APPENDIX A

PROGRAM ANALYSIS
INCENTIVES TO REPLACE PRE-1987 HEAVY-DUTY VEHICLE

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A. Background

Pre-1987 heavy-duty diesel trucks still comprise a significant portion of the truck population in California. These vehicles typically operate at California's ports, haul aggregate material in and out of densely populated areas, operate around-the-clock, and on a seasonal basis, hauling agricultural products, as well as other non-line haul, local delivery applications. The engines in these trucks are continuing to be rebuilt since the truck owners/operators typically do not have the financial resources to buy newer trucks. Furthermore, in cases where it is financially feasible for the owner to buy a newer vehicle, there may not be a real economic reason for doing so since these trucks are usually employed in lower revenue service compared to line-haul or other applications.

According to the ARB's emission inventory model (EMFAC2000), pre-1987 heavy-duty diesel trucks still account for about 20 percent of the total heavy-duty diesel truck population statewide. This correlates to about 76,000 pre-1987 trucks still in use throughout California. While these older trucks typically drive fewer miles and make fewer trips than newer trucks, their emissions are still significant since these engines were subject to less stringent NOx emission standards and were uncontrolled relative to PM emissions. Figures A-1 and A-2 compare the population, miles traveled, and NOx and PM emissions for heavy-duty diesel trucks statewide, in increments of five model years.

B. 1994 Ozone SIP Measure M-7

There is a need to reduce emissions from this segment of the heavy-duty diesel truck sector, to reduce ozone and benefit the health of all Californians. The ARB, in fact, proposed a concept for accelerating the retirement of heavy-duty vehicles in its 1994 Ozone State Implementation Plan (SIP) as measure M-7. That measure envisioned the annual retirement (scrapping or removal) of about 1,600 of the oldest, highest emitting trucks in the South Coast Air Basin, beginning in 1999 and continuing through 2010.

FIGURE A-1
POPULATION AND VMT--STATEWIDE

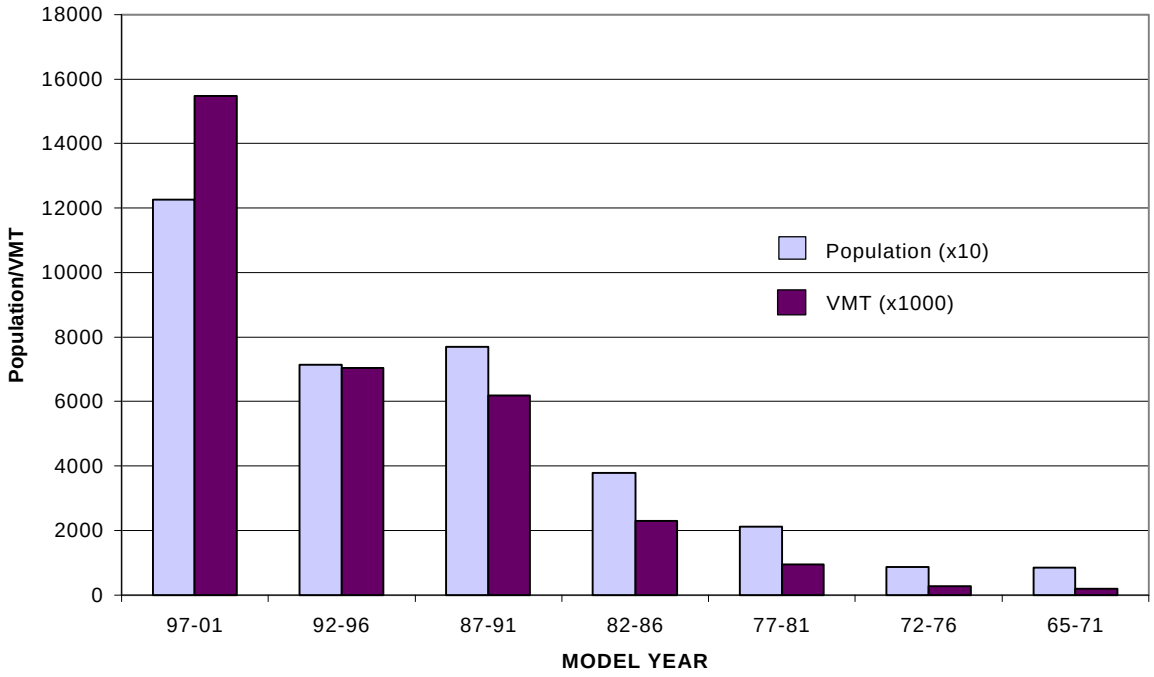
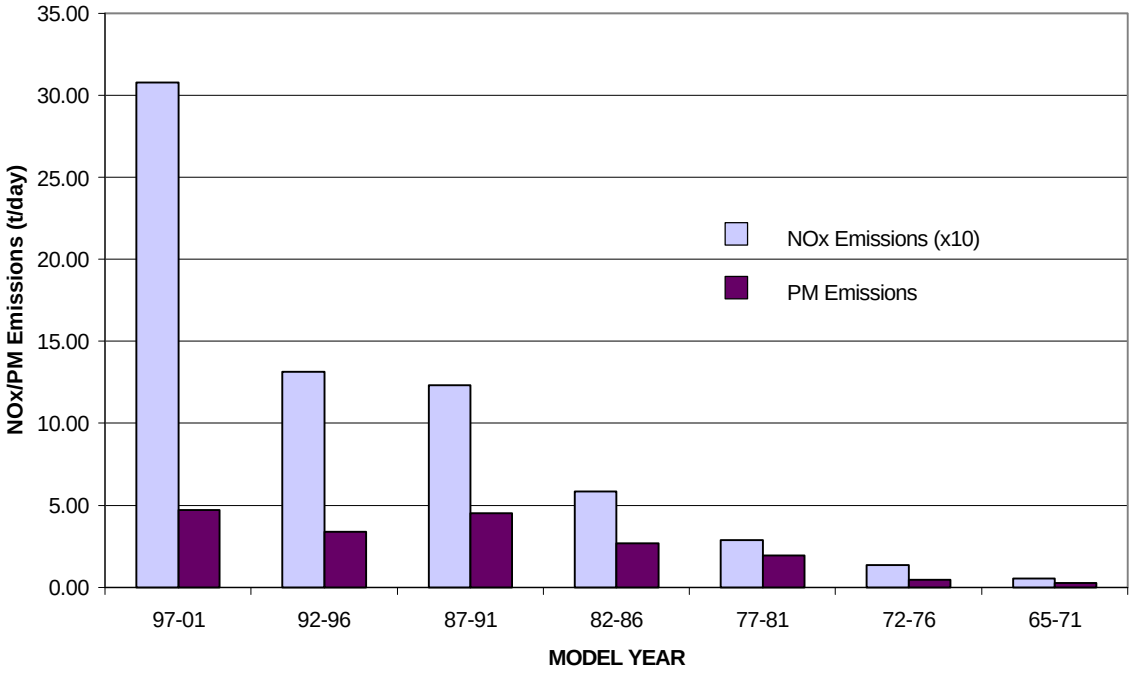


FIGURE A-2
NOx and PM EMISSIONS--STATEWIDE



At the time the 1994 ozone SIP was adopted, ARB staff anticipated that the retirement program could be self-sustaining through the sale of both the best old trucks (for export) and recovered parts from scrapped trucks. However, as ARB staff worked with the trucking industry and other stakeholders to develop this measure, it became clear that measure M-7 would not be able to deliver the emission reductions for two reasons -- lack of funding and expected emission benefits. The prospects for a self-funded program dimmed when the anticipated overseas market for old California trucks did not materialize and ARB better understood the value of these older vehicles to their owners. Analysis also indicates that the older, high emitting trucks removed from the fleet are not likely to be replaced with cleaner vehicles, but rather with trucks of similar age from outside the area, providing little or no emission benefit. Based on these concerns, M7 was withdrawn from the SIP.

C. Feasibility of Incentivizing the Early Replacement of Pre-1987 Heavy-Duty Vehicles

ARB staff was directed by the Advisory Board to evaluate the feasibility of developing a heavy-duty vehicle retirement program within the framework of the Carl Moyer Program. Drawing from ARB's knowledge learned from SIP measure M-7, two critical factors must be addressed to ensure a successful heavy-duty vehicle retirement program. First ARB must determine adequate funding. Second, ARB staff must determine a method for quantifying emission reductions associated with such a program. Staff evaluated various options to achieve additional emission reductions from pre-1987 trucks, including truck repowering and incentivizing the early replacement of pre-1987 heavy-duty vehicles. Based on the preliminary results of that analysis, staff was not able to develop a cost-effective program. The data indicate that while some emission reductions may be achieved, these programs may not be feasible based on associated program cost-effectiveness and emission benefits. The sections below provide details pertaining to the results of ARB staff's analysis.

1. Pre-1987 Truck Repowering Option

Initially, repowering with electronic engines appears to be a very attractive and cost effective strategy for reducing emissions from pre-1987 heavy-duty diesel trucks. The emissions from these vehicles are higher compared to later model year vehicles. Pre-1987 heavy-duty diesel trucks were subject to a NOx emission standard of about 10 g/bhp-hr while PM emissions were uncontrolled and are assumed to be much greater than 0.6 g/bhp-hr, which is the PM standard effective with 1987 model year trucks. There may be a chance to reduce emissions from a small segment of these trucks by implementing a strategy that removes the older engines in these trucks and replaces them with later model year engine. In most of these trucks, however, a project would be economically unfeasible based on certain technical challenges due to significant differences in engine designs.

Pre-1987 heavy-duty diesel engines typically have the injection timing mechanically controlled instead of electronically controlled as are common in 1991 and later model year engines. In addition, pre-1987 engines generally have different power characteristics, especially the torque profile, compared to later model year engines. Repowering a pre-1987 mechanical engine to a later model year electronic engine would not be a simple engine swap, but would entail numerous details that must be addressed. Besides the intuitively expected installation of a new wiring harness to accommodate the increased presence of electronics, other engine and vehicle components, such as a new radiator to handle the increased engine heat, must be upgraded as well. In addition, the existing transmission and rear end of the truck would need to be examined to ensure that those components would be sufficiently robust to accept the increased power from the new engine. Because those components were originally designed to optimize performance with a different engine, and because of component deterioration associated with age, they may also need to be replaced. Even in cases where those components are deemed to be strong enough for the new engine, the gearing for the truck will likely need to be changed to better accommodate the new engine characteristics and to optimize any emission reduction benefits. The reason is that the existing vehicle gearing may be incorrectly matched to the engine output such that the engine cannot operate efficiently. This would result in poor performance and increased emissions.

While the technical challenges of repowering pre-1987 trucks with electronic engines could be overcome, the resultant cost may cause this strategy to be economically unattractive. For example, the basic cost for this type of repowering is estimated to be about $30,000, including new engine, radiator, wiring harness, other engine-related components, and labor. If the gearing needs to be changed, and if the transmission needs to be replaced, the cost could increase to about $40,000. Contrasting this cost to the market value of the truck, and anticipated emission benefits, this type of project cannot be justified based on the cost-effectiveness criterion of $12,000/ton. Staff estimates that based on that cost-effectiveness criterion, the maximum Moyer amount that could be granted for this type of repowering project would be about $8,500 to $12,000. This assumes that the repowered truck will be driven the same number of miles and employed in the same service as the older truck. This amount is well below the expected cost for this type of project. The owners/operators for these vehicles generally operate on very slim profit margins and typically would not be expected to have the financial resources to pay for the difference in expected costs. Thus, staff believes that for most of these engines, this strategy may not be successful in reducing emissions.

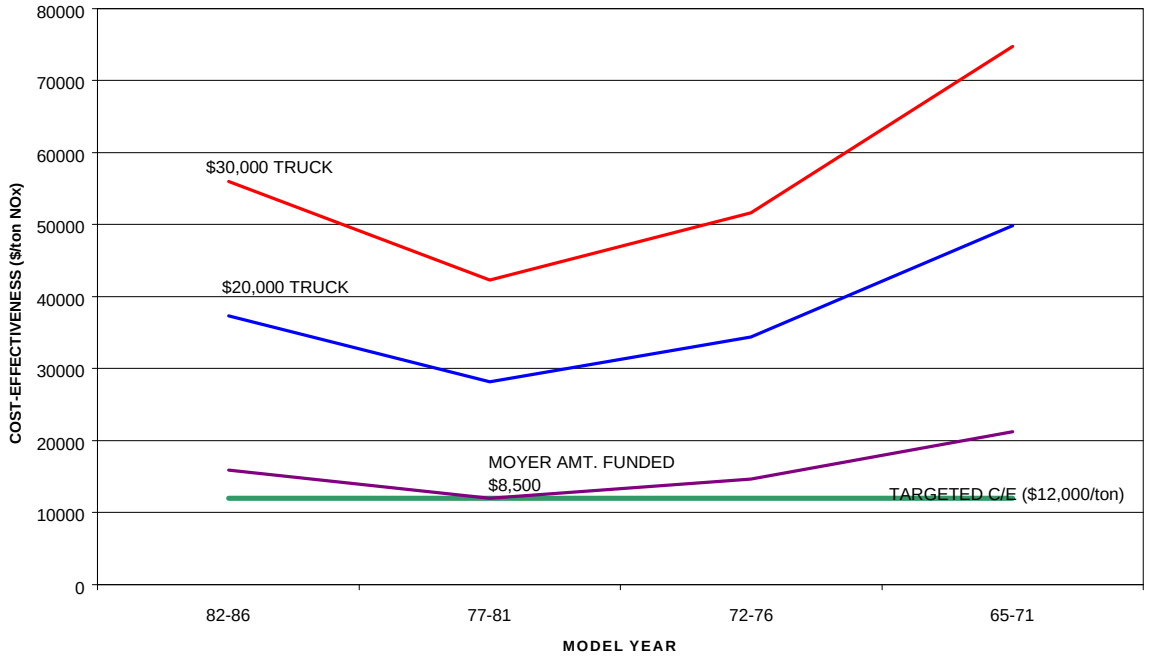
2. Early Replacement of Pre-1987 Trucks/New Purchase Option

This strategy is an early replacement of pre-1987 truck strategy. The focus of this strategy is to provide incentives for pre-1987 truck owners to retire their trucks and replace them with newer, less polluting, 1994 and later model year, trucks. In many ways, this strategy is very similar to measure M-7 of the 1994 Ozone SIP discussed earlier. It is, therefore, not very surprising that the reasons causing measure M7 to be

infeasible are very much the same reasons why the current option is anticipated to be unsuccessful.

The first key issue is funding. Whereas, measure M-7 depended on market forces to fund a self-sustaining program through the sales of some old trucks to oversea markets and through the sales of parts from scrapped trucks, the current proposal would rely on Moyer funds to support this accelerated vehicle replacement program. In this case, Moyer funds would be granted for the purchase of 1994 and later model year heavy-duty trucks. Staff's preliminary assessment of the used truck market shows that the market price for a used 1994 or newer truck ranges from $20,000 to $30,000. Based on staff's earlier analysis for the repowering option, the maximum amount of Moyer fund that could be paid out would be about $8,500 to $12,000 per truck purchased under this program. Again, this is based on a cost-effectiveness criterion of $12,000 per ton of NOx emissions reduced, assuming the new truck will be driven the same number of miles and employed in the same service as the older truck. Figure A-3 illustrates the cost-effectiveness that could be expected for this type program over the range of estimated costs for buying a newer truck. From this scenario, a truck owner would need to expend from $8,000 to $21,500 to obtain the newer truck. It is unlikely that a truck owner would be willing to invest this amount to buy a newer truck under this Moyer program, especially since his/her current truck is still operating. Also, as discussed earlier, the revenue generated from the type of work these trucks are employed in cannot justify this investment.

FIGURE A-3
COST-EFFECTIVENESS OF PRE-1987
HEAVY-DUTY TRUCK RETIREMENT PROGRAM



The second key issue is to ensure that real and quantifiable emission reductions are achieved. Under measure M-7, emission benefits were determined to be much less than originally anticipated when the 1994 Ozone SIP was developed. The reasons being that truck owners really have no incentives to sell their old trucks since the market price for such trucks is severely undervalued relative to their utility to the truck owners. In addition, even when an owner decides to sell the truck, perhaps because the truck has deteriorated to the point where it does not make economic sense to repair it, the owner would very likely buy another truck of similar, or marginally newer, vintage due to financial constraints. Under this scenario, any emission benefits attributable to a vehicle retirement program would be very minimal.

Under the option being investigated, this situation would remain essentially unchanged, even if the old truck were required to be completely destroyed, so that it could not reenter the used truck market. There are various reasons for this observation, mainly due to the dynamics of the used truck market and the economics of this sector.

First, these old trucks are typically employed in services with relatively small revenue and profit by smaller fleet operators. A fleet operator who opted to purchase a newer truck must be able to justify the economics of the added payment for the new purchase. If the newer truck were to be employed in similar service, where the revenue stream presumably would be the same as with the older truck, the added payment for the newer truck would not be justifiable. Some of the added cost maybe able to be offset through fuel savings and reduced maintenance costs associated with the newer truck. But these savings would need to be substantial to improve the economics of the purchase. If, as a result of having the newer truck, the truck owner decides to switch to a more lucrative business that could be performed with the newer truck, the old service would be taken over by other operators. These other operators would very likely use older trucks to conduct business, the type of trucks that this program is trying to eliminate. This is because older trucks can be purchase from both in state and out-of-state truck market, at relatively low prices. Thus, the total population of older trucks would not be reduced significantly even if some truck owners could be entice to participate in the proposed Moyer program.

Another factor that would reduce the emission benefit that could be expected with this program is the off-cycle emissions associated with electronic engines. While the difference in the NOx emission standards for pre-1987 and 1994-and-later heavy-duty engines is more than 5 g/bhp-hr, the actual difference in in-use emissions is much less due to off-cycle emissions. As presented in Chapter II, Table II-6, the baseline emissions for pre-1987 heavy heavy-duty vehicles range from 7.5 g/bhp-hr to 9.8 g/bhp-hr and 1994-1998 heavy heavy-duty vehicles range from 7.3 g/bhp-hr to 8.9 g/bhp-hr. Thus, as a result of off-cycle emissions, the emission benefits of an accelerated heavy-duty vehicle replacement program are not as great as initially appeared.

D. Conclusions

Based on the foregoing analysis, staff believes that incentivizing the early replacement of pre-1987 heavy-duty vehicles would not be justified on either cost or emission benefit considerations. The combination of cost that would need to be funded and the relatively small real emission reductions that could be obtained, causes the cost-effectiveness to be quite high compared to other possible projects that could be funded with Moyer money. A heavy-duty truck owner would be required to put out additional money, not an insignificant amount in most cases, to compensate for the amount not covered by Moyer money. As discussed, a truck owner in this market would not likely have the resources, or the inclination, to do so.